# BORON FAMILY (IIIA Group Elements)

**UNIT: 1**

1 General introduction, electronic configuration , occurrence

2 Variation of properties, oxidation states, trends in chemical reactivity

3 Anomalous properties of first element of the group

4 Boron – Physical and chemical properties and uses

5 Some important compounds: Borax; Boric acids; Boron hydrogen

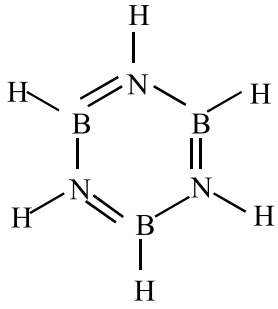
**VERY SHORT ANSWER QUESTIONS :**

**1. What is the general electronic configuration of IIIA group elements ?**

A. The general electronic configuration of IIIA group elements are $ns^2\ np^1$

**2. Give the formula and structure of Borazine.**

A. Borazine is $B_3N_3H_6$ and its structure is




**3. Write the general formulae of two types of boranes ?**

A. Boranes are classified into two types

1) $B_nH_{n+4}$

Eg : $B_2H_6 \longrightarrow$ Diborane

$B_5H_9 \longrightarrow$ Pentaborane – 9

2) $B_n\,H_{n+6}$

Eg : $B_4H_{10} \longrightarrow$ Tetraborane – 10

$B_5H_{11} \longrightarrow$ Pentaborane – 11

**4. Give the formula of tincal and Colemanite ?**

A. Tincal $\longrightarrow$ Impure form of Borax, $Na_2B_4O_7.10H_2O$

Colemenite $\longrightarrow Ca_2B_6O_{11}.5H_2O$

**5. What is banana bond ?**

A. Three centred two electron bond B-H-B in diborane is called banana bond.

**6. Boron does not exist free in nature. Why ?**

A. Due to high reactive Boron does not exist free in nature.

**7. Write conditions required for diborane to react with CO ?**

A. Temperature $1000°C$ and pressure 2 atm

**8. What is the orbital structure of diborane ?**

A. Refer structure of Diborane

**9. What is "inert pair effect" ?**

A. The reluctance of ns – electrons to participate in a chemical reaction is called "inert pair effect".e.g Thalium ehibits +1 O.S due to inert pair effect,

**10. Identify the inert pair in indium.**

A. $5s^2$ valency electrons are responsible for inert pair effect

**11. What is the common oxidation state of group IIIA elements ? How does it change down the group ?**

A. Common oxidation state of group IIIA elements is +3, its stability decreases down the group.

**SHORT ANSWER QUESTIONS**

**1. Write down the boron family elements in the order. Write the electronic configuration of 2rd, 3rd and 4th elements of the group.**

A. Boron, Aluminium, Gallium, Indium and Thallium

$Al = 1s^2\,2s^2\,2p^6\,3s^2\,3p^1$

$Ga = 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^1$

$In = 1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^{10}\,4s^2\,4p^6\,4d^{10}\,5s^2\,5p^1$

**2. Name the sources of Boron, Gallium, Indium and Thallium.**

A. Boron : Borax - $Na_2B_4O_7, 10H_2O$

Boric acid : $H_3BO_3$

Gallium : found in the ores of Zn, Al and Ge

Indium and Thallium : Occur along with ZnS and galena, PbS

**3. Explain the following sequence of IE's in group IIIA. B (801), AI (577) ; Ga (579) ; In (558) ; T (589)** $kJ/mole$

A. The first IE values decreases from B Al significantly. However there is not so much change in the $1^{st}$ IE values as we go from Ga to In. The atomic radius increases considerably from B to Al. This due to the great screening effect to electrons present in the penultimate shell. That is why the first IE values decreases considerably from B to Al.

**4. Explain the EN values of Ga, In and Ti do not vary much through they are expected to decrease in the group.**

A. In the long form of the periodic table, Ga, In and Ti follow d – block elements. The d – electrons present cannot shield the valence electrons from the nuclear attractions. Consequently, their valence electrons present in the outermost shell are attracted strongly. Hence, the E.N. values increases from Ga to TI with increase in nuclear charge, though they are expected to decrease.

**5. Define oxidation state. How does it vary in the group ?**

A. The apparent charge of an atom in its combined state is known as its oxidation state.

All the elements of IIIA group exhibit a common oxidation state of +3. Except boron and aluminium all other elements show +1 oxidation state. This +1 state becomes more and more stable, as we go down the group.

**6. Which is a better reducing agent boron or silicon ? How can you prove it ?**

A. Boron is a powerful reducing agent and reduces $SiO_2$ to Si

$$3SiO_2 + 4B \longrightarrow 2B_2O_3 + 3Si$$

**7. Draw the structure of Metaborate ion.**

A. Formula of the ion is $\left[B_4O_5\right]\left(OH_4\right)^{2-}$

**8. Explain with a suitable example borax bead test.**

A. Borax Bead Test : This test is useful for the identification of coloured metal radicals in qualitative analysis. On heating, borax swells into a white, opaque mass of anhydrous sodium tetraborate. When it is fused, borax glass is obtained. This contains sodium metaborate and $B_2O_3$. The boric anhydride

combines with metal oxides to form metal metaborates as coloured beads. The reactions are as follows.

$$\underset{\text{Borax}}{Na_2B_4O_7.10H_2O} \longrightarrow Na_2B_4o_7 \xrightarrow{fused} \underbrace{2NaNO_2 + B_2O_3}_{\text{Borax glass}}$$

$$B_2O_3 + CoO \longrightarrow \underset{\text{Cobalt Metaborate (Blue head)}}{Co(BO_2)_2}$$

**9. Mention any 3 uses of Borax.**

A. Borax is used

1) as a flux in soldering, welding and in certain metallurgical processes

2) in making optical glass and pyrex glass

3) in leather industry for cleaning hides and skin

4) as a preservative

**10. Write the formulas of all the boric acids.**

A. Orthoboric acid : $H_3BO_3$ Metaboric acid : $HBO_2$

Tetraboric acid : $H_2B_4O_7$ Pyroboric acid : $H_6B_4O_7$

**11. What are Boranes ? How are they classified ?**

A. Compounds of Boron with hydrogen are known as boranes. They are classified into two types. They are :

1) Those with the general formula $B_nH_{n+4}$

Ex : $B_2H_6$, $B_5H_9$, $B_6H_{10}$ etc

2) Those with the general formula $B_nH_{n+6}$

Ex : $B_4H_{10}$, $B_5H_{11}$, $B_6H_{12}$ etc

**12. A mixture of hydride of boron and ammonia are passed through a hot tube. What is the result ?**

A. a) When passed through a hot tube at $120°C$, $B_2H_6.2NH_3$ is formed

$$B_2H_6 + NH_3 \longrightarrow \underset{\text{Diammoniate of diborane}}{B_2H_6.2NH_3}$$

b) When passed through a hot tube at $200°C$, $B_3N_3H_6$ is formed

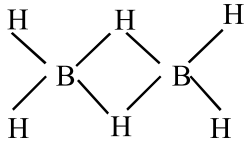
$$B_2H_6.2NH_3 \longrightarrow B_3N_3H_6\,(\text{Borazole})$$

**13. What is the orbital structure of $B_2H_6$ ? Explain.**

A. Molecules in which the central atom gets less than octet configuration are called electron deficient molecules. Ex : Diborane $B_2H_6$

Structure of diborane :

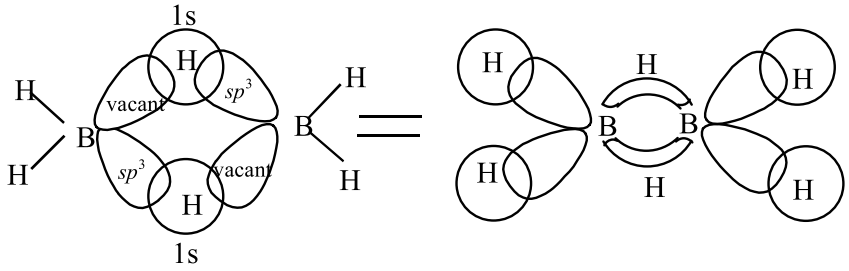
Electron diffraction studies have shown the diborane contains two coplanar $BH_2$ groups and its structure can be represented as




The four H atoms present in the $BH_2$ groups are known as terminal hydrogen atoms. The remaining two H atoms are called as Bridge hydrogens. The two bridge hydrogens lie in a plane perpendicular to the plane of the two $BH_2$ groups. Out of the two bridge hydrogen one H atom lies below the plane and the other H atom lies above the plane.

Orbital structure of Diborane :

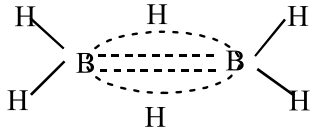
In diborane each born atom undergoes $sp^3$ hybridization resulting in four equivalent $sp^3$ hybrid orbitals. Three of these orbitals have one electron each and the fourth hybrid orbital is vacant. In forming the B- H – B bridge. $sp^3$ hybrid orbital with one electron from one boron atom. Is orbital of one bridge hydrogen and the vacant $sp^3$ hybrid orbital of the second boron atom overlap as shown below.




**Overlap of orbitals in $B_2H_6$ - Banana bond**

The two B-H-B bridges present ind diborane are abnormal bonds. They are considered as three centered two electron bonds. This type of bond is called banana bond or tau bond. In this type of bond a pair of electrons holds three atoms. In diborane there are two such bridges.

The Diborane structure can also be represented as shown below




**Diborane molecule**

**14. How can you prove chemically the bridge structure of $B_2H_6$ ?**

A. The bridge structure of Diborane is confirmed by the presence of two types of hydrogens by NMR and Raman spectral studies. This is further confirmed by methylation of Diborane to give $Me_4B_2H_2$. The two hydrogens which cannot be methylated are different from the other four hydrogens and are called Bridge hydrogen atoms.

**LONG ANSWER QUESTIONS :**

**1. What properties in the group IIIA elements show gradation ? Explain the irregularity.**

1) At room temperature all these elements are solids
2) Boron is a non – metal while the others are reactive metals
3) Density of these elements increase from B to Tl. The low density of Al is due to its larger atomic value.
4) The MP of 'B' is very high because it exists as a giant covalent polymer both in liquid and solid states. The low MP of 'Ga' is due to its simple molecular structure. It consists of '$Ga_2$' molecules.
5) B.P's of these elements are high and decrease regularly from B to Tl
6) The atomic radius increases considerably from B to Al. This is due to greater screening effect of electrons present in the penultimate shell. In the atoms of Ga, In and Tl the electrons in the penultimate shell do not shield the valence electrons from nuclear attractions effectively and hence the outer electrons are attracted strongly by the nucleus. Because of this reason, they possess smaller atomic sizes than expected
7) The first ionization energy values of these elements decrease from "B" to "Al" significantly. However, there is no remarkable change in the I.E. values from "Ga" to "In". The second a third I.E values are quite high and the trend is similar to that observed with first IE values.
8) The E.N. values of these elements decrease from B to Al and then increase upto Tl. The reason for the decrease in the E.N. values from B to Al to due the large size of the Aluminium atoms. The reason for the increase in the EN values from Al to Tl can explained as follows. The d – electrons present in them cannot shield the valence electrons from the nuclear attractions. Consequently, the valence electrons present in the out most shell are attracted strongly. Hence the electronegativity of the elements will be higher.

**2. Write an essay on the anomalous behaviour of Boron.**

A. Boron differs from the other elements of the group significantly because of

1) Its small size

2) The difference in the penultimate shell configuration

3) High first ionization potential

**Anomalous properties are :**

1) Boron is a non metal. Al is an amphoteric metal Ga, In and Tl are metals
2) It always forms covalent compounds while other may form ionic compounds.
3) Boron shows diagonal relationship with Si. Such a relationship is not shown by other elements.
4) Boron does not displace hydrogen from acids while other elements, being metals, displace hydrogen from acids under suitable conditions.
5) $B_2O_3$ is an acidic oxide like $SiO_2$. The trioxides of other elements are either amphoteric or basic in nature.

   Ex : $Al_2O_3 \Rightarrow$ amphoteric, TlOH is strong base

6) $B(OH)_3$ or $H_3BO_3$ is an acid while the hydroxides of other elements are either amphoteric or basic in nature.

Simple borates and silicates can polymerize readily forming poly-acids while others do not form such polymers.

Boron has maximum covalency 4 and whole others have 6

Boron form covalent hydrides which are stable

It never appears a cation whereas the other elements have a good number of compounds in which the element form trivalent cations.

The halides of B except $BF_3$ hydrolyze readily and vigorously in water whereas the other metal halides undergo partial hydrolysis (or) no hydrolysis with water.

**3. Write any six chemical properties of Boron.**

A. On heating Boron reacts with non – metals like $O_2$, $N_2$, etc forming binary compounds.

$$4B + 3O_2 \longrightarrow 2B_2O_3$$

2) Boron is a powerful reducing agent and reduces $SiO_2$ and $CO_2$ to their elements

$$3SiO_2 + 4B \longrightarrow 2B_2O_3 + 3Si$$

3) Amorphous boron, on heating in air to about $700°C$ forms $B_2O_3$ and BN

$$4B + 3O_2 \longrightarrow 2B_2O_3\,(\text{Boron trioxide})$$

$$2B + N_2 \xrightarrow{\Delta} 2BN\,(\text{Boron nitride})$$

4) Boron reacts with sulphur at $1200°C$ and forms $B_2S_3$

$$2B + 3S \longrightarrow B_2S_3\,(\text{Boron trisulphide})$$

5) Boron reacts with carbon on heating and form Boron carbide

$$4B + C \longrightarrow B_4C$$

6) Boron reduces the strong oxidizing acids $HNO_3$ or $H_2SO_4$ to NO or $SO_2$. B itself oxidized to ortho Boric acid.

$$B + 3HNO_3 \longrightarrow H_3BO_3 + 3NO$$

$$2B + 3H_2SO_4 \longrightarrow 2H_3BO_3 + 3SO_2$$

7) When fused with alkalies, Boron liberates $H_2$ gas

$$2B + 6NaOH \longrightarrow 2Na_3BO_3 + 3H_2$$

**4. Write any two forms of borax that occur in nature. Give their formulae. Explain the principle of Borax bead test with atleast one example.**

A. **Forms of Borax :**

1) Prismatic borax : $Na_2B_2O_7.10H_2O$

2) Octahedral borax : $Na_2B_4O_7.5H_2O$

**Borax Bead Test :** This test is useful for the identification of basic radicals in qualitative analysis. On heating, Borax swells into a white, opaque mass of anhydrous sodium tetraborate. When it is fused, borax glass is obtained. This contains sodium metaborate and $B_2O_3$. The boric anhydride combines with metal oxides to form metal metaborates as coloured beads. The reactions are as follows

$$Na_2B_4O_7.10H_2O \longrightarrow \underset{\text{White, opaque mass}}{Na_2B_4O_7} \xrightarrow{\text{fused}} \underbrace{2NaBO_2 + B_2O_3}_{(\text{Borax glass})}$$

$$B_2O_3 + CoO \longrightarrow \underset{\text{Blue bead}}{Co(BO_2)}(\text{Cobalt metaborate})$$

**5. Name all the boric acids and give their formulae. Discuss the preparation of orthoboric acid from Colemanite.**

A. **Names and formulae of Boric acids :**

Orthoboric acid $H_3BO_3$

Metaboric acid $HBO_2$

Tetraboric acid $H_2B_4O_7$

Pyroboric acid $H_6B_4O_7$

Among all the boric acids orthoboric acid is the most important. Orthoboric acid is simply called as boric acid. It is prepared from Colemanite $(Ca_2B_6O_{11})$

Colemanite is finely powdered, suspended in hot water and $SO_2$ gas is passed till saturation.

The boric acid solution is separated by filtration, concentrated and subjectd to crystallization. Then boric acid crystallizes out.

$$Ca_2B_6O_{11} + 9H_2O + 2SO_2 \longrightarrow 2CaSO_3 + 6H_3BO_3$$

**6. What is the pecularity of the hydrides of Boron ? Write on what do you know about them.**

A. Boron hydrides are one of the important class of compounds of boron. The boron hydrides can be compared with hydrocarbons. These are all electron – deficient compounds.

Based on their molecular formulae, boron hydrides are classified into 2 types. They are also called boranes.

Examples for $B_nH_{n+4}$ type :

$B_2H_6$ diborane : $B_5H_9$ pentaborane – 9

Examples for $B_nH_{n+6}$ type :

$B_4H_{10}$ tetra borane - 10 ; $B_5H_{11}$ penta borane – 11

$B_6H_{12}$ hexaborane – 12

Boranes are important in view of their structures and uncommon compositions. These boranes are better fuels than the hydrocarbons.

**7. Write an essay on the preparation and chemical activity of Diborane.**

A. **Preparation of Diborane :**

1) Boron trifluoride on reduction with LiH at 450K gives Diborane

$$2BF_3 + 6LiH \longrightarrow B_2H_6 + 6LiF$$

2) On passing silent electric discharge through a mixture of boron trichloride and hydrogen, diborane is formed

$$2BCl_3 + 6H_2 \longrightarrow \underset{\text{Diborane}}{B_2H_6} + 6HCl$$

**Chemical Properties :**

1) Diborane reacts with water and gives Boric acid

$$B_2H_6 + 6H_2O \longrightarrow 2H_3BO_3 + 6H_2$$

2) Diborane burns with halogens (except $I_2$) at different temperatures and gives different products

$$B_2H_6 + 6Cl_2 \xrightarrow{25^\circ C} 2BCl_3 + 6HCl$$

$$B_2H_6 + Br_2 \xrightarrow{100^\circ C} B_2H_5Br + HBr$$

3) Diborane burns in oxygen and liberates large amount of water

$$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O$$

$$\Delta H = -2006.4\,kJ$$

4) Diborane reacts with ammonia as shown below :

$$B_2H_6 + NH_3 \xrightarrow{120^\circ C} \underset{\text{Diammoniate of diborane}}{B_2H_6.2NH_3}$$

$$B_2H_6.2NH_3 \xrightarrow[200^\circ C]{\Delta} \underset{\text{Borazole}}{B_3N_3H_6}$$

The structure of borazole is similar to that of benzene. Hence it is called inorganic benzene.

5) In presence of $AlCl_3$ catalyst, HCl reacts with diborane and gives chlorodiborane

$$B_2H_6 + HCl \xrightarrow{AlCl_3 \text{ catalyst}} B_2H_5Cl + H_2 \uparrow$$

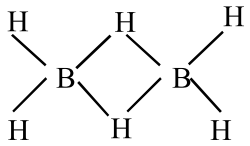
**8. What do you mean by electron – deficient molecules ? Give two examples. Explain the structure of Diborane.**

A. Molecules in which the central atom gets less than octet configuration are called electron-deficient molecules.

Ex : (1) Diborane $B_2H_6$ 2) Boron trifluoride $BF_3$

Structure of diborane :

Electron diffraction studies have shown that diborane contains two coplanar $BH_2$ groups. Its structure can be represented as

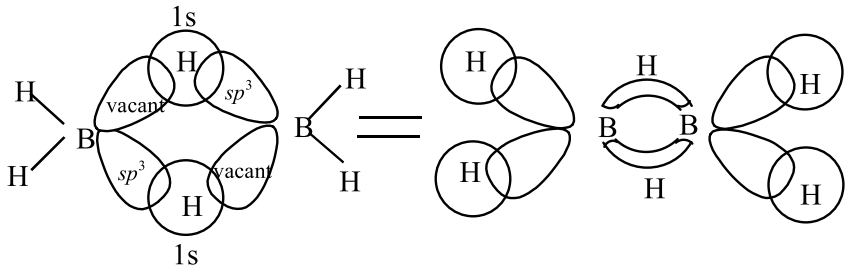



The four H atoms present in the $BH_2$ groups are known as terminal hydrogen atoms. The remaining two H atoms are called as Bridge hydrogens. The two bridge hydrogens lie in a plane perpendicular to the plane of the two $BH_2$ groups. Out of the two bridge hydrogens, one H atom lies above the plane and the other H atom lies below the plane.

Orbital structure of Diborane :

In Diborane each boron atom undergoes $sp^3$ hybridization resulting in four equivalent $sp^3$ hybrid orbitals. Three of these orbitals have one electron each and the fourth hybrid orbital is vacant. In forming the B-H-B bridge. $sp^3$ hybrid orbital with one electron from one boron atom. Is orbital of

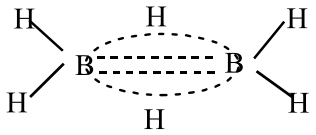
one bridge hydrogen and the vacant $sp^3$ hybrid orbital of the second boron atom overlap as shown below.




**Overlap of orbital in $B_2H_6$ – Banana bond**

The two B- H- B bridges present in Diborane are abnormal bonds. They are considered as three centered two electron bonds. This type of bond is called banana bond or tau bond. In this type of bond a pair of electron holds three atoms. In Diborane there are two such bridges.

This Diborane structure can also be represented as shown below.




**Diborane molecule**

**9. Explain any two methods of preparation of diborane. Write the reactions of $B_2H_6$ with (a) $H_2O$ (b) $Cl_2$. Give equations.**

A. **Methods of preparation of Diborane :**

1) Boron trifluoride on reduction with LiH at 450K gives diborane

$$2BF_3 + 6LiH \longrightarrow B_2H_6 + 6LiF$$

2) On passing silent electric discharge through a mixture of boron trichloride and hydrogen, diborane is formed

$$2BCl_3 + 6H_2 \longrightarrow \underset{\text{Diborane}}{B_2H_6} + 6HCl$$

**a) Reaction with $H_2O$ :**

Diborane reacts with water and produces boric acid

$$B_2H_6 + 6H_2O \longrightarrow \underset{\text{Boric acid}}{2H_3BO_3} + 6H_2$$

**b) Reaction with $Cl_2$ :**

Diborane reacts with $Cl_2$ at $25°C$ and gives $BCl_3$

$$B_2H_6 + 6Cl_2 \xrightarrow{\text{at } 25°C} 2BCl_3 + 6HCl$$

**10. What happens when (a) Boron is heated with $CO_2$ (b) Orthoboric acid is heated gradually (c) Borax and $MnSO_4$ are fused on a platinum wire (d) Diborane is heated with $NH_3$**

A. a) Carbon is formed

$$B + 3CO_2 \longrightarrow 2B_2O_3 + 3C$$

b) Orthorboric acid loses water gradually and finally gets converted into boron trioxide

$$H_3BO_3 \xrightarrow{100°C} HBO_2 + H_2O$$

$$4H_3BO_3 \xrightarrow{100°C} H_2B_4O_7 + 5H_2O$$

$$2H_3BO_3 \xrightarrow{\text{high temp}} 3H_2O + B_2O_3$$

c) Violet coloured manganese metaborate is formed (Borax Bead Test)

$$Na_2B_4O_7.10H_2O \longrightarrow Na_2B_4O_7 \xrightarrow{\text{fused}} \underset{\text{Borax glass}}{2NaBO_2} + B_2O_3$$

$$B_2O_3 + MnSO_4 \longrightarrow \underset{\text{Manganese metaborate}}{Mn(BO_2)_2}$$

d) At $120°C$, diborane reacts with ammonia, to give diammoniate of diborane. This on again heating at $200°C$ gives $B_3N_3H_6$ (borazone)

$$B_2H_6 + 2NH_3 \xrightarrow{120°C} B_2H_6.2NH_3$$

$$B_2H_6.2NH_3 \xrightarrow{200°C} B_3N_3H_3(\text{Borazole})$$

**11. Starting with Borax, how can you obtain the following (a) $B_2O_3$ (b) Boron nitride (c) Sodium metaborate**

A. a) Borax on heating swells into white, opaque mass of anhydrous sodium tetraborate. When this fused, $B_2O_3$ obtained.

$$Na_2B_4O_7.10H_2O \longrightarrow Na_2B_4O \xrightarrow{fused} \underset{\text{sodium metaborate}}{2NaNO_2} + B_2O_3$$

b) Borax on heating with $H_2SO_4$ gives boric acid

$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow Na_2SO_4 + 4H_3BO_3$$

c) On heating the boric acid, metaboric acid and finally $B_2O_3$ are formed

$$H_3BO_3 \xrightarrow[-H_2O]{370\,K} HBO_2 \xrightarrow{\text{red heat}} B_2O_3$$

This $B_2O_3$ on heating with nitrogen gives boron nitride

$$2B_2O_3 + 2N_2 \longrightarrow \underset{\text{Boron nitride}}{4BN} + 3O_2$$

d) Borax on heating swells into a white, opaque mass of anhydrous sodium tetraborate. This on fusion gives sodium metaborate

$$Na_2B_4O_7 \,.10H_2O \longrightarrow Na_2B_4O \xrightarrow{fused} \underset{\text{sodium metaborate}}{2NaNO_2} + B_2O_3$$

# BORON FAMILY (IIIA Group Elements)

**UNIT: 2**

1. Alunimiun: Uses, reactions with acids and alkalies
2. Potash alum

**VERY SHORT ANSWER QUESTIONS:**

**1. Write the composition of Magnalium. Mention its uses.**

A. It contains 20 – 15% Mg, 85 – 98% Al. It is very tough and strong. It is used in making cheap balances and lab utensils.

**2. Guess why Al alloys are used in making parts of aircraft?**

A. Al alloys are used in making the parts of aircraft due to light weight, tough and corrosion resistant.

**3. Mention any two uses of Al ?**

A. 1) Al powder is used in Aluminothermite process

2) Used as de-oxidiser in metallurgy

**4. Write the applications of Potash alum ?**

A. 1) Used in the purification of water

2) It is used as a styptic to arrest bleeding

**5. What is meant by "pyrites shale"?**

A. Powder form of natural sulphides of metals are called pyrites shale.

Eg : $Al_2O_3\ xSiO_3 + FeS_2$

**SHORT ANSWER QUESTIONS**

**1. Name any two alloys of 'Al'. Give their compositions.**

A. (1) Duralumin: 2 – 15 % Mg: 85 - 98 % Al

(2) Magnalium: 10 -12% Al; 88 – 90% Cu

**2. Write the reaction of 'Al' with acids.**

A. (1) With both dil and conc acids 'A' gives $H_2$ gas

$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2$

(2) With dil $H_2SO_4$ 'Al' liberates $H_2$ gas

$2Al + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2$

With conc. $H_2SO_4$ 'Al' gives $SO_2$ gas

$2Al + 6H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 6H_2O + 3SO_2$

(3) Very dil $HNO_3$ is reduced to $NH_4NO_3$ by 'Al'

$8Al + 20HNO_3 \longrightarrow 8Al(NO_3)_3 + 3NH_4NO_3 + 9H_2O$

**LONG ANSWER QUESTIONS:**

**1. Write any method of preparation of potash alum. Mention any two uses of alum.**

A. **Preparation of potash alum :**

1) On concentration of a solution of equimolar quantities of $K_2SO_4$ and $Al_2(SO_4)_3$ to the point of crystallization, potash alum separates out.

$K_2SO_4 + Al_2(SO_4)_3.18H_2O + 6H_2O \longrightarrow K_2SO_4.Al_2(SO_4)_3.24H_2O$

2) Alunite is boiled with dil. $H_2SO_4$. To it calculated amount of $K_2SO_4$ is added and subjected to crystallization. Then potash alum crystallizes out.

$K_2SO_4.Al_2(SO_4)_3.4Al(OH)_3 + H_2SO_4 \longrightarrow \left[K_2SO_4 + 3Al_2(SO_4)_3 + 12H_2O\right]$

$\left[K_2SO_4 + 3Al_2(SO_4)_3 + 12H_2O\right] + 2K_2SO_4 + 60H_2O \longrightarrow 3\left[K_2SO_4.Al_2(SO_4)_3.24H_2O\right]$

Uses of Alum :

1) used in the purification of water

2) used as a mordant in dyeing

3) used as a styptic to arrest bleeding

**2. Explain the following:**

**(a) Banana bond**

**(b)** $KAl(SO_4)_2.12H_2O$ **is an alum but** $FeSO_4.Al_2(SO_4)_3.24H_2O$ **is not**

**(c) B differs from other elements of the group**

A. a) In diborane there are two B – H – B bridges. They are considered as three centered two electron bonds. This bond is also known as banana bond.

b) An alum contains monovalent and trivalent metals. So $KAl(SO_4)_2.12H_2O$ is an alum (K = monovalent and Al = trivalent). $FeSO_4.Al_2(SO_4)_3.24H_2O$ is not an alum. Since, there is no monovalent metal. (Fe = divalent and A = trivalent)

c) Boron differs from the other elements of the same family in the following respects

i) Boron is a non – metal while the others are metalloids and metals

ii) Boron always forms covalent compounds while others form ionic compounds

iii) Boron does not displace $H_2$ from acids while the others can displace $H_2$ from acids

iv) Boron exhibits a maximum covalency of 4. But others exhibit a maximum covalency of 6